Decentralized Wastewater Treatment Systems:

Processes, Design, Management, and Use

Webinar Series Sponsored by the Conservation Technology Information Center, US EPA, and Tetra Tech

Session 3

Decentralized Wastewater System Design: Part 1

Victor D'Amato, Tetra Tech

Decentralized Wastewater Design

- Part 1 – Design Fundamentals
  - Planning and Design Basis
  - Wastewater Characterization
  - Preliminary/Primary Treatment
  - Soil-Based Treatment
  - Distribution Design for Soil Dispersal

Decentralized Wastewater Design

- Part 2 – Advanced Design Topics
  - Pumping Systems
  - Clustered Collection and Treatment
  - Advanced Treatment
  - Repairs, Expansions, and Retrofits
  - Construction Management and Supervision
  - Operation and Maintenance

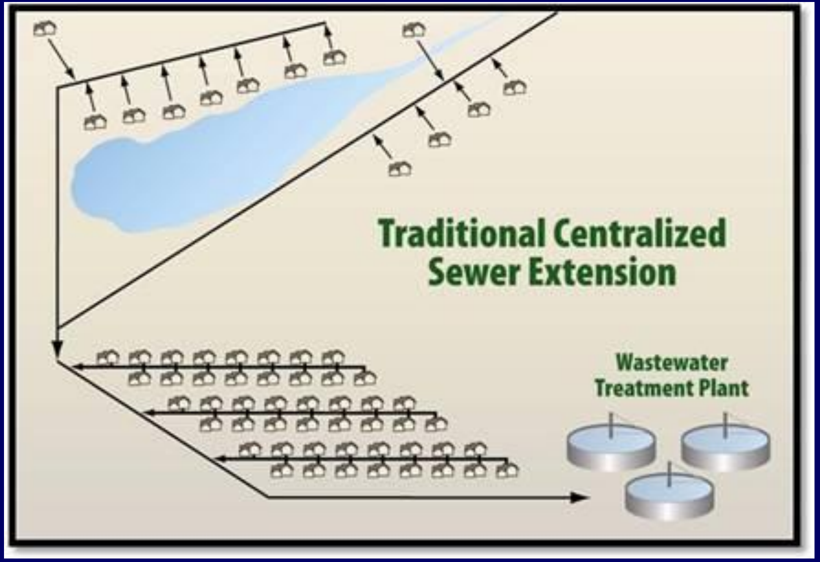
Planning and Design Basis

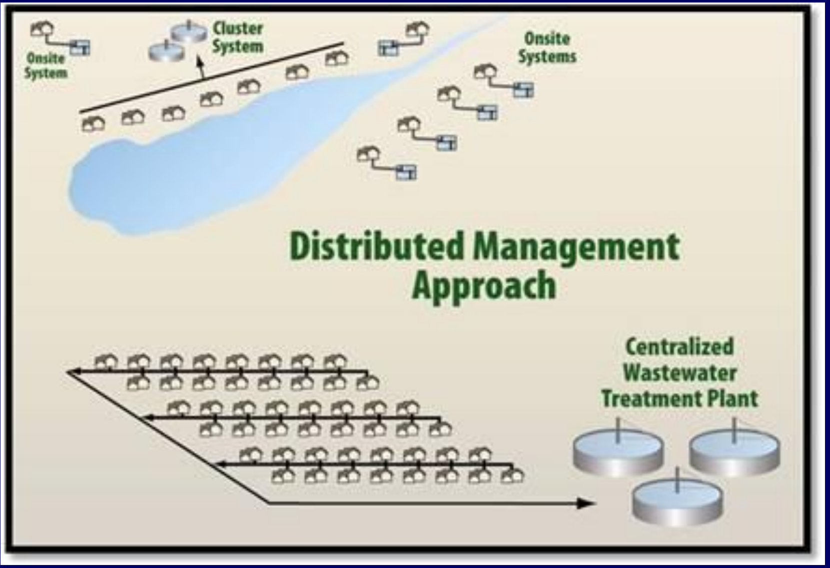
Planning Processes

- Preliminary Engineering Review (PER)
  - Requirement for USDA-RUS and other funding
  - RUS Bulletin 1780
    - Project planning area
    - Existing facilities
    - Need for project
    - Alternatives considered
    - Selection of alternative
    - Proposed project
    - Conclusions and recommendations
- Capital Improvement Plan (CIP)
  - Infrastructure/asset management planning medium-long term (1 yr, 5 yr, longer)

System Layout/Architecture

- Centralized systems
- Decentralized systems
  - Individual (onsite/onlot)
  - Cluster
- *Distributed management*: use and management of systems scaled to match context



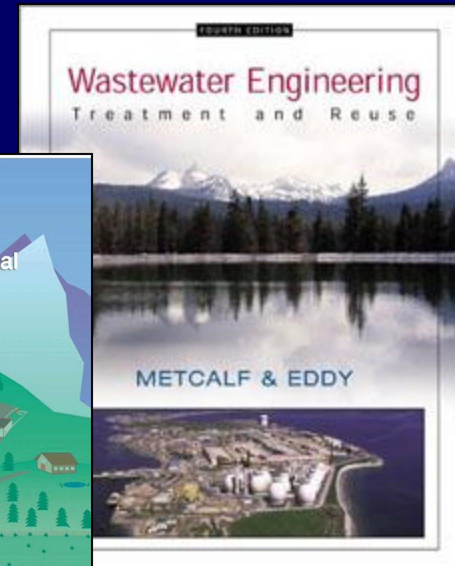


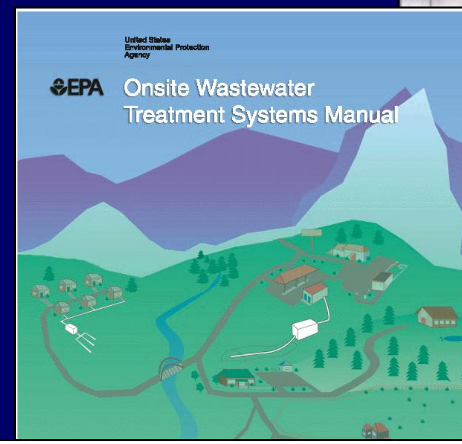
System Components

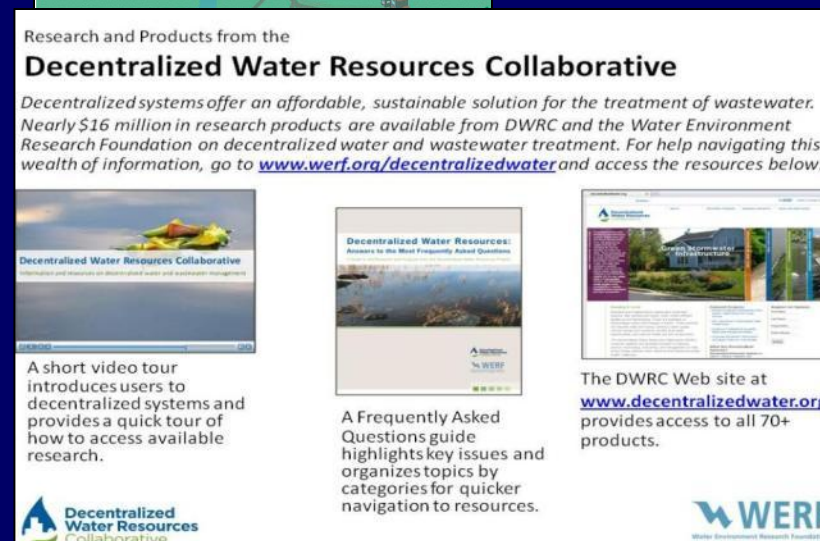
- **Collection/Conveyance** (part 2)
  - Conventional (gravity/lift station)
  - STEP/STEG
  - Pressure Sewer
  - Vacuum Sewer
- **Treatment**
  - Preliminary/Primary (part 1)
  - Secondary (part 2)
  - Advanced/Tertiary (part 2)
- **Product Management**: Effluent, Residuals
  - Discharge vs. soil dispersal vs. reuse
  - Surface vs. subsurface dispersal
  - Gravity vs. pressure distribution

Key References

- State/local regulations
- 10-State Standards (http://10statesstandards.com/waterstandards.html)
- *Wastewater Engineering*, Metcalf and Eddy
- *Small and Decentralized Wastewater Management Systems*, Crites and Tchobanoglous
- Water Environment Federation Manuals of Practice (MOPs)
- EPA Manuals (http://www.epa.gov/nrmrl/pubs/625r00008/html/625R00008.htm)
- Decentralized Water Resources Collaborative/WERF project products (http://www.ndwrcdp.org/)
- Unit converter






Research and Products from the

Decentralized Water Resources Collaborative

Decentralized systems offer an affordable, sustainable solution for the treatment of wastewater. Nearly $16 million in research products are available from DWRC and the Water Environment Research Foundation on decentralized water and wastewater treatment. For help navigating this wealth of information, go to www.werf.org/decentralizedwater and access the resources below:

A short video tour introduces users to decentralized systems and provides a quick tour of how to access available research.

A Frequently Asked Questions guide highlights key issues and organizes topics by categories for quicker navigation to resources.

The DWRC Web site at www.decentralizedwater.org provides access to all 70+ products.

Decentralized Water Resources Collaborative

WERF

Wastewater Characterization

Wastewater Characterization

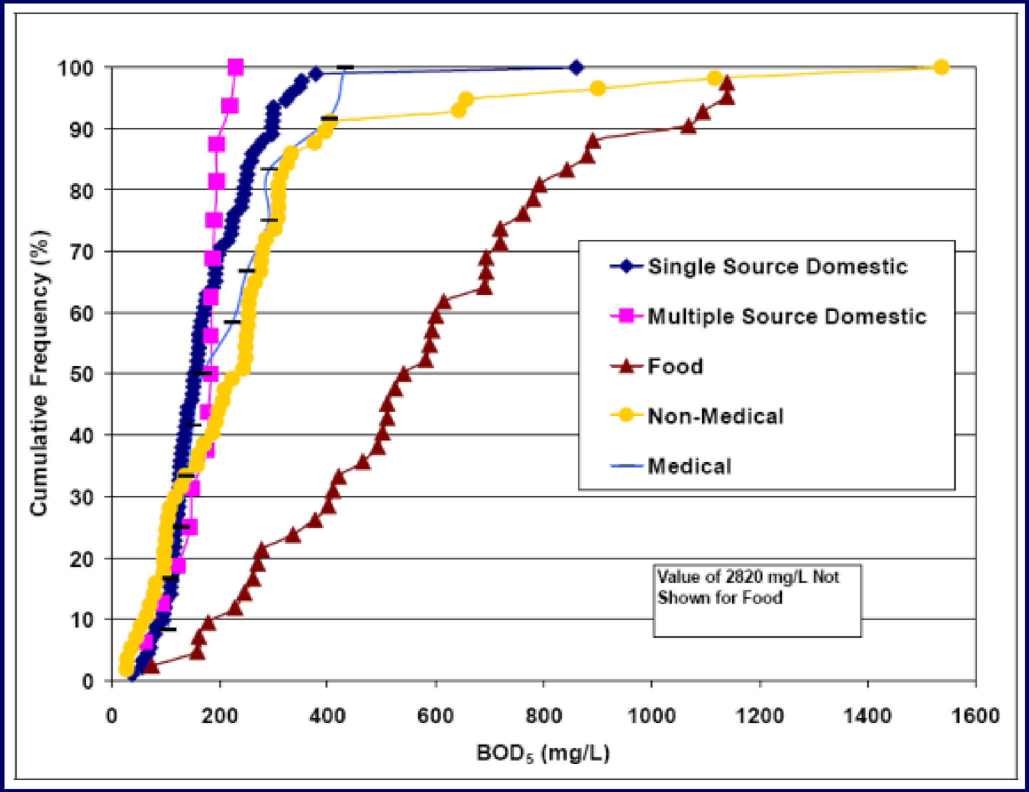
- Flow, Q = Volume/time (gal/day)
- Strength expressed in concentration, c (mg/l)
- Mass loading = Qc (lbs/day)
  - Most meaningful measure
  - Only used to size certain pretreatment units
  - Both flow and strength should be *assessed* in any system design
  - Flow and strength are functions of the *facilities* being served

- Mass loading calculation example
  - Q = 1,200 gpd
  - c(BOD_5) = 300 mg/l
  - BOD_5 loading = 1,200 gal/day X 300 mg/l X 3.9 l/gal X 2.2E-6 lbs/kg = **3.1 lbs/day**

Wastewater Strength

- Domestic (from *Metcalf and Eddy*)
  - TSS = 120-400 mg/l
  - BOD5 = 110-350 mg/l
  - FOG = 50-100 mg/l
  - TN = 20-70 mg/l
  - TP = 4-12 mg/l
  - Others?
- Institutional (high N?)
- Commercial (high BOD, FOG?)
- Industrial (high metals, toxics?)
- Combinations
- *Sampling raw wastewater, especially from stand-alone facilities is difficult (sample STE if possible)*

Wastewater Strength



CFD for Septic Tank Effluent BOD$_5$ Concentration – *This diagram shows, for example, that ~70 percent of the STE BOD$_5$ results reported in the literature for single-source domestic systems are 200 mg/L or less.*

- Lowe, et al. (2007) http://www.ndwrcdp.org/research_project_04-DEC-1.asp
- Lesikar, et al. (2004) *Food-service Establishments Wastewater Characterization* and (2005) *The Strength of Wastewater as Impacted by Restaurant Management Practices*

Wastewater Flow

- What basis?
  - **Peak day (gpd)**
  - Peak month average (gpd)
  - Annual average (gpd)
  - Peak hour (gpm)
- **Prescriptive**: unit flow rates for different facilities
- **Data-driven**: measured flow rates from facility
  - e.g., average of three highest daily flows in peak month
- *Estimating daily design flow can be tricky – make sure you get this right before proceeding!*

TABLE NO. I

TYPE OF ESTABLISHMENT	DAILY FLOW FOR DESIGN
Airports (Also R.R. stations, bus terminals --not including food service facilities)	5 gal/passenger
Barber Shops	50 gal/chair
Bars, Cocktail Lounges (Not including food service)	20 gal/seat
Beauty Shops (Style Shops)	125 gal/chair
Bowling Lanes	50 gal/lane
Businesses (other than those listed elsewhere in this table)	25 gal/employee
Camps	
Construction or Work Camps	60 gal/person 40 gal/person (with chemical toilets)
Summer Camps	60 gal/person
Campgrounds -- With Comfort Station (Without water and sewer hookups)	100 gal/campsite
Travel Trailer/Recreational Vehicle Park (With water and sewer hookups)	120 gal/space
Churches (Not including a Kitchen, Food Service Facility, Day Care or Camp)	3 gal/seat
Churches (With a Kitchen but, not including a Food Service Facility, Day Care, or Camp)	5 gal/seat
Country Clubs	20 gal/member
Day Care Facilities	15 gal/person
Factories (Exclusive of industrial waste)	25 gal/person/shift
Add for showers	10 gal/person/shift
Food Service Facilities	
Restaurants	40 gal/seat or 40 gal/15 ft2 of dining area, whichever is greater
24-hour Restaurant	75 gal/seat
Food Stands	
(1) Per 100 square feet of food stand floor space	50 gal
(2) Add per food employee	25 gal
Other Food Service Facilities	5 gal/meal
Hospitals	300 gal/bed
Marinas	10 gal/boat slip
With bathhouse	30 gal/boat slip
Meat Markets	
(1) Per 100 square feet of market floor space	50 gal
(2) Add per market employee	25 gal

Wastewater Flow

- Example
  - Summer camp w/250 campers, max., full-service cafeteria, no laundry
  - State rules prescribe:
    - 30 gpd/camper
    - 60 gpd/camper with laundry and food service
    - 5 gal/meal served

- Solution
  - Prescribed unit flow = 30 gpd/camper + (5 g/meal)(3 meal/day-camper) = 45 gpd/camper
  - Design daily flow = 250 campers x 45 gpd/camper = 11,250 gpd
  - Peak month of June 2009 had three max. WW flows of 10,235, 13,794, and 9,650 gpd (average = 11,226 gpd)
  - *Retrofit fixtures and monitor*

Wastewater Flow

- Variability
  - **Hourly**
    - Generally, the fewer facilities, the higher the peaking factor
  - **Daily** – schools, churches, businesses
    - May equalize over 7 days if flow varies across a normal week
  - **Weekly** – for variable use facilities, vacation rentals, etc.
    - Ensure that treatment processes can withstand variable loading or design to address
  - **Seasonal** – for vacation areas
    - Ensure that treatment processes can withstand long periods of inactivity

	Number People at Camp	Sewer Flow Meter Readings	Actual Sewer Per Day (gal)
6/7/2009	35		
6/8/2009	35	3765.04	
6/9/2009	35	3781.78	1674
6/10/2009	35	3811.84	3006
6/11/2009	35	3838.33	2649
6/12/2009	35	3880.33	4200
6/13/2009	35		
6/14/2009	188		
6/15/2009	188	3957.69	
6/16/2009	188	4060.04	10235
6/17/2009	188	4197.98	13794
6/18/2009	188	4294.48	9650
6/19/2009	188	4356.37	6189
6/20/2009	5	4379.61	2324
6/21/2009	172		
6/22/2009	172	4408.31	
6/23/2009	172	4454.3	4599
6/24/2009	172	4507.04	5274
6/25/2009	172	4537.95	3091
6/26/2009	5	4565.09	2714
6/27/2009	5		
6/28/2009	152		
6/29/2009	152	4615.38	
6/30/2009	152	4649.87	3449
7/1/2009	152	4681.75	3188
7/2/2009	152	4721.1	3935
7/3/2009	5	4743.48	2238
7/4/2009	5		
7/5/2009	208		
7/6/2009	208	4802.73	
7/7/2009	208	4852.44	4971

Preliminary/Primary Treatment

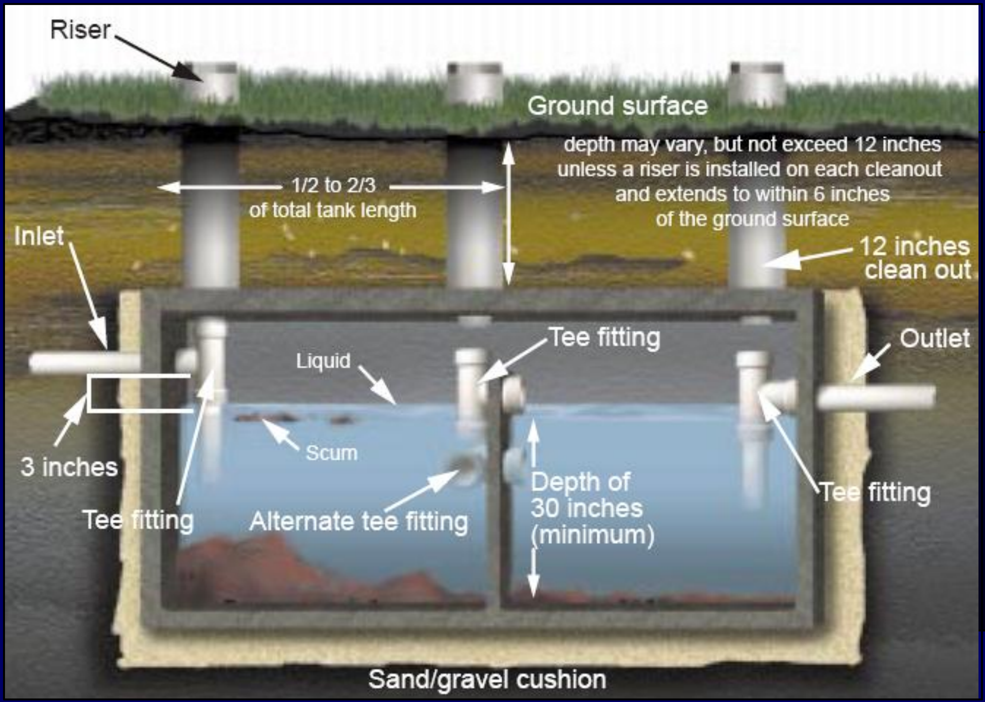
Preliminary/Primary Treatment

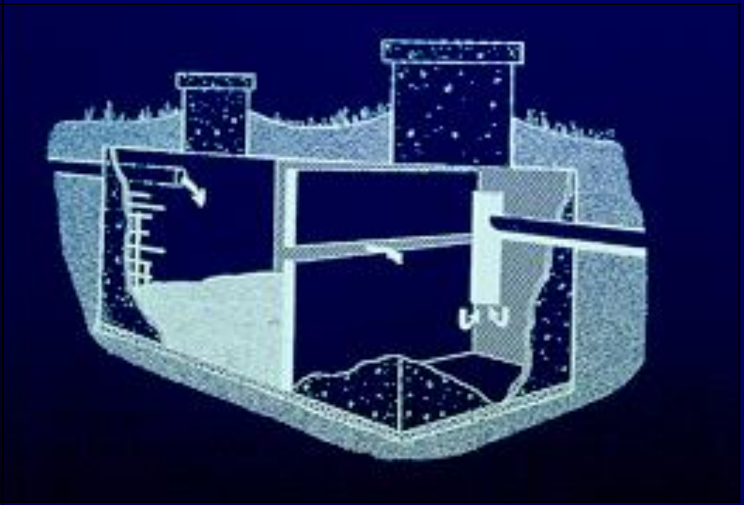
- Preliminary treatment
  - Processes that remove materials and objects that may cause O&M problems (e.g., rags, grit, sticks, grease)
- Primary treatment
  - Processes that remove a portion of the suspended solids and organic material

- Typically provided by ***septic tanks*** and ***grease traps*** in decentralized systems
  - Conventional screening and grit/grease removal may be provided when extended aeration treatment plants are used for pretreatment

Septic Tank Functions

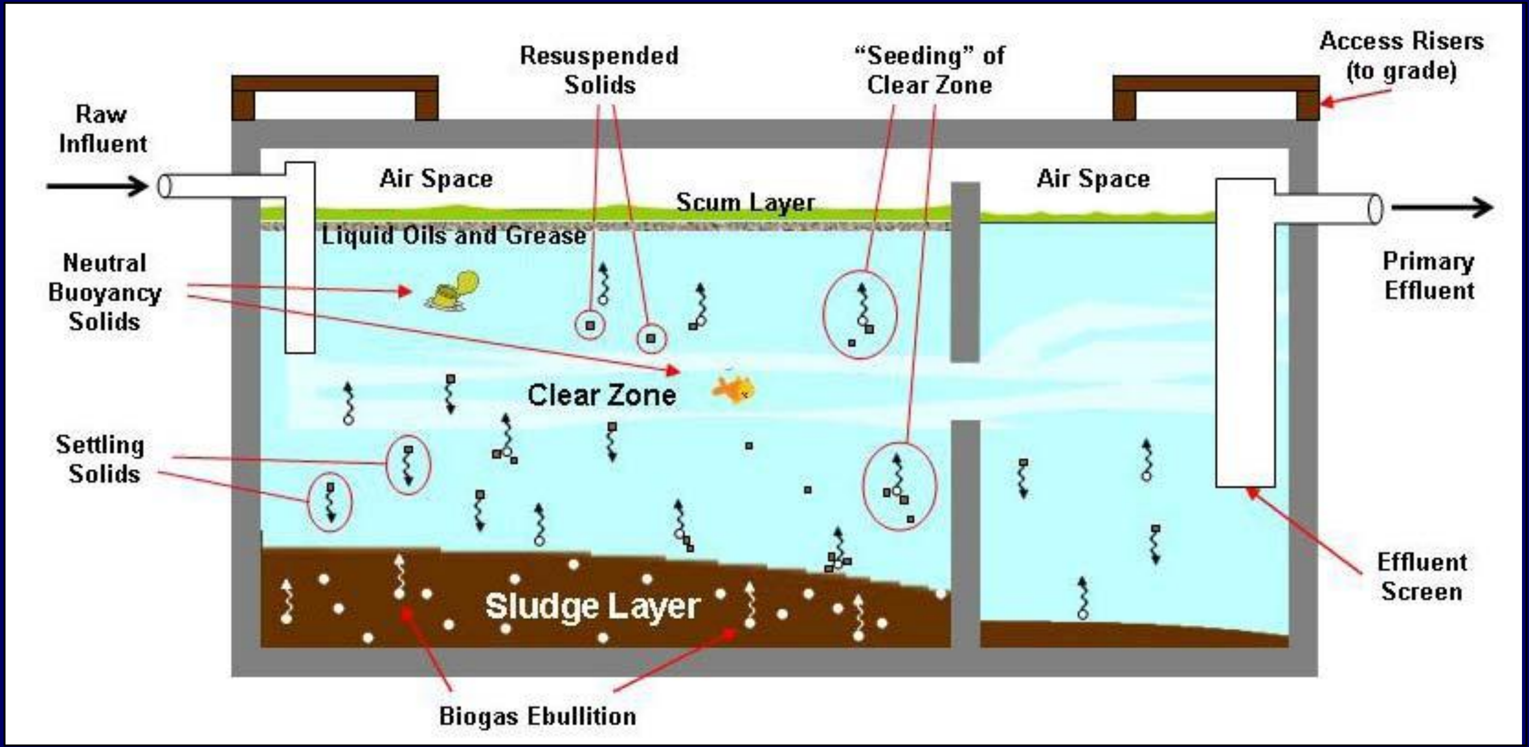
- Treatment
  - Solids removal (60-80%)
  - BOD removal (50-60%)
  - O&G removal (up to 80%)
  - Limited removal of nutrients, pathogens, metals, etc.
- Storage and digestion of solids/scum
- Flow modulation
- Conditioning of wastewater for further treatment
- Protection of drainfield/downstream components
- Advanced pretreatment system component (recirc)
- Resource recovery (nutrients, biogas)





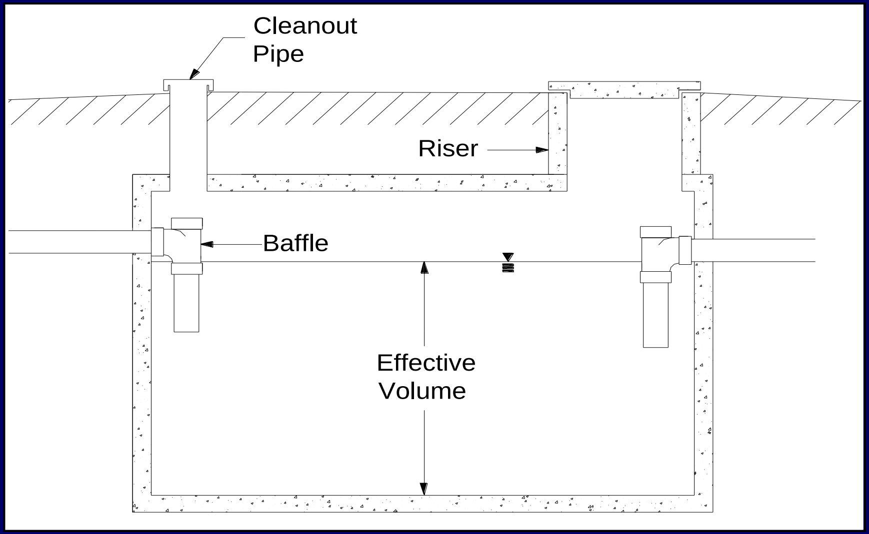
Septic Tank Operational Model

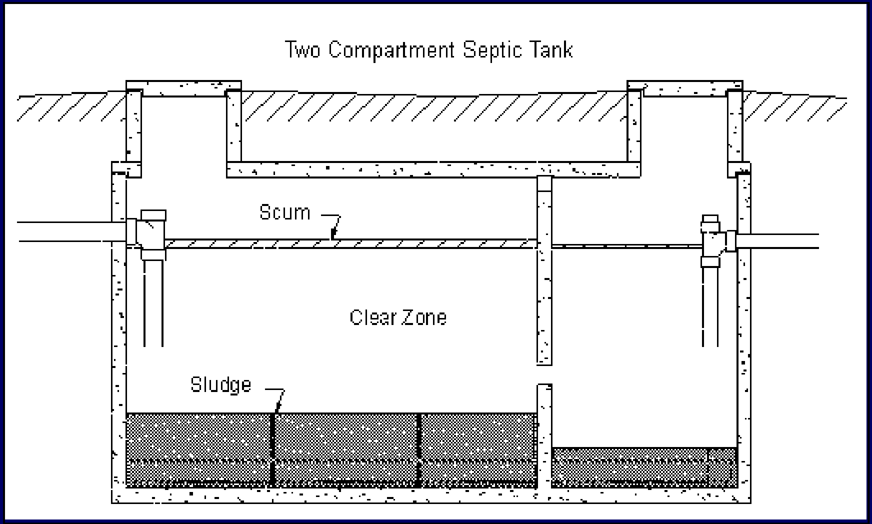
- Mechanically simple, but functionally complex
- Organic molecules are converted into easily degradable sugars and acids (through hydrolysis) followed by further degradation by methane forming organisms
- Distinct layers of settled sludge, a clear zone and floating scum form
- Biogas bubbles rise from the sludge layer to seed the upper layers and disrupt settling



Septic Tank Design

- Sizing typically based on a 1-2 day HRT at design flow (max day)
- Design elements usually prescribed by state or local codes
  - Sizing requirements
  - Compartmentation (baffles)
  - Effluent screening devices
  - Usually standard designs, but engineered units may be used for larger or non-traditional applications

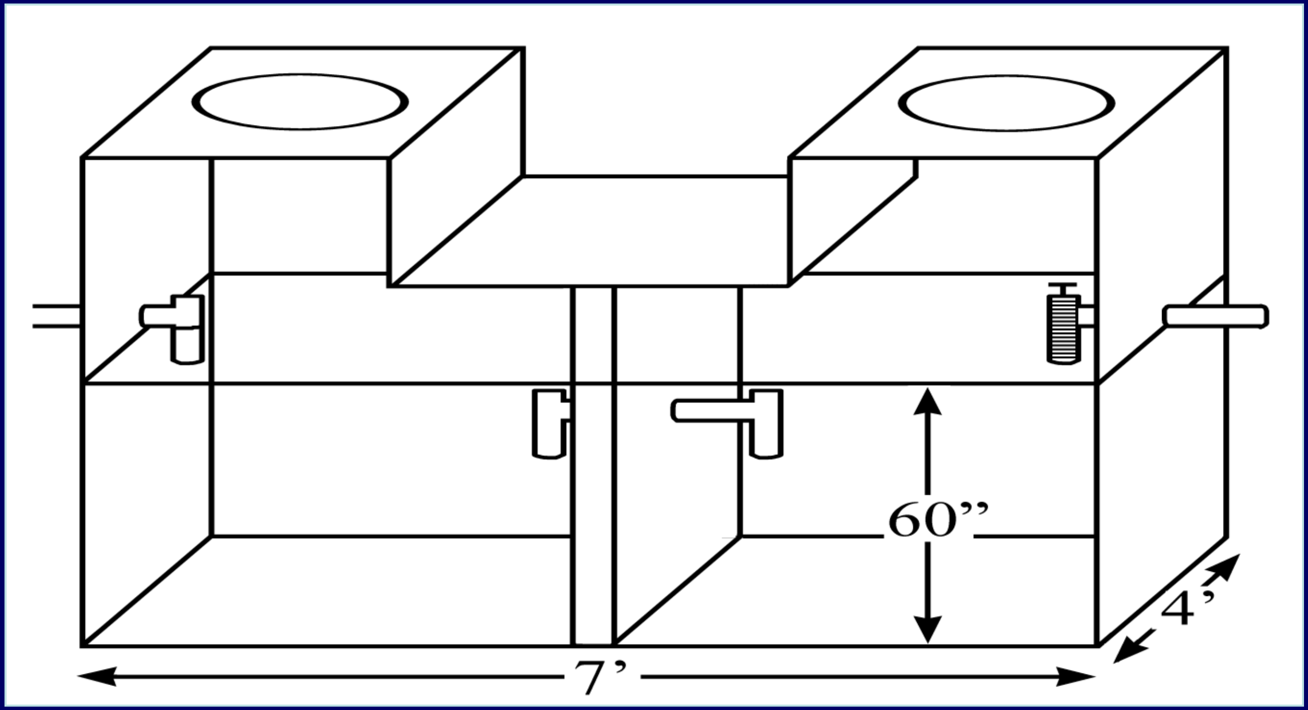




Septic Tank Capacity Calculation

- Use INSIDE dimensions of the tank
- Operating depth is measured from bottom to OUTLET
- Volume = length x width x depth (to the bottom of the outlet)

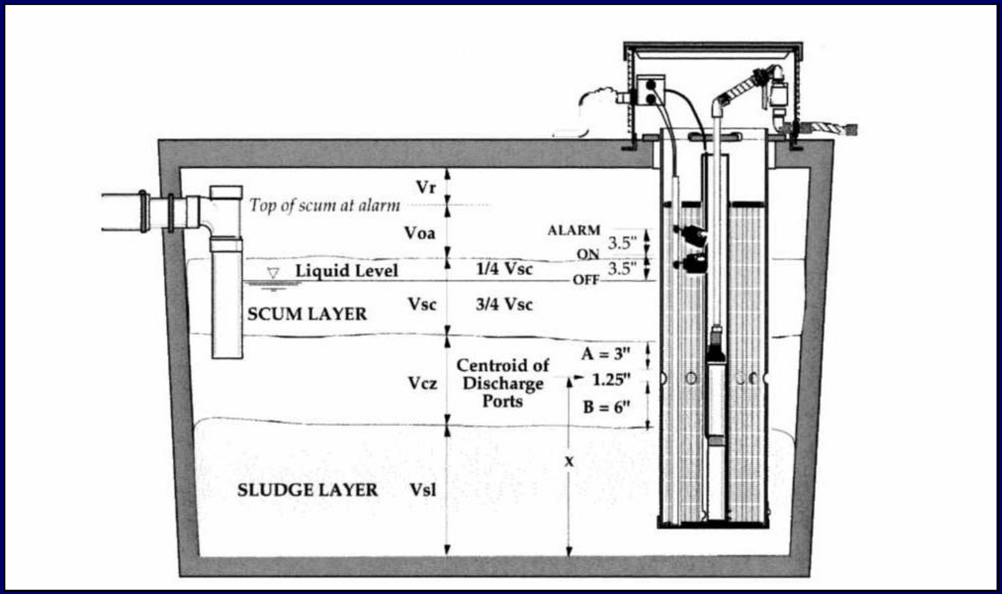
- Example
  - 4’ x 7’ x [60” / 12] = 4’ x 7’ x 5’ = 140 ft^3
  - 140 ft^3 x 7.5 gal/ft^3 = 1,050 gal
  - 1050 gal / 60 inches = 17.5 gallons per inch



Septic Tank Design Factors

Septic Tank Sizing

- Size has more of an impact on pumping frequency than settling
- Larger tanks have higher capital costs but require less frequent pumping and have lower operation and maintenance costs
- Larger tanks with less frequent pumping may take longer to reach biological maturity but are ultimately more efficient digesters



(Bounds, 1994)

Hydraulic Considerations	Design Elements
Surface loading rate	Surface area
Flow characteristics (short circuiting)	Compartmentation (intercompartment transfer device) Geometry Inlet design
Exit velocity	Outlet sizing Effluent hydraulic control

Septic Tank Design Factors

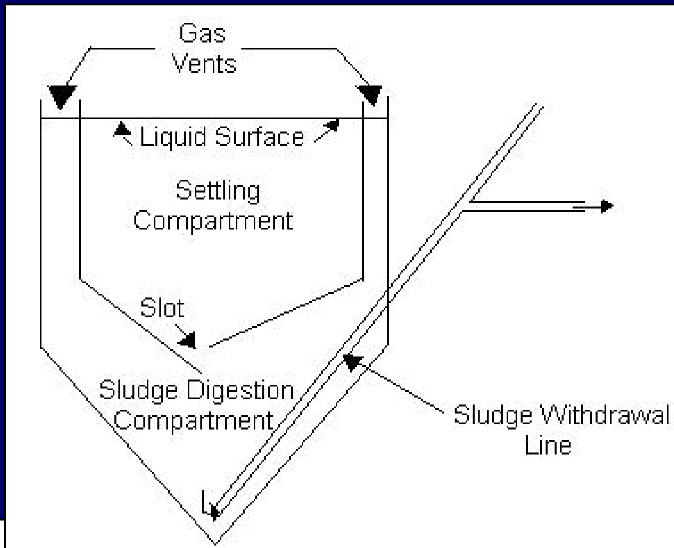
<u>Geometry</u>

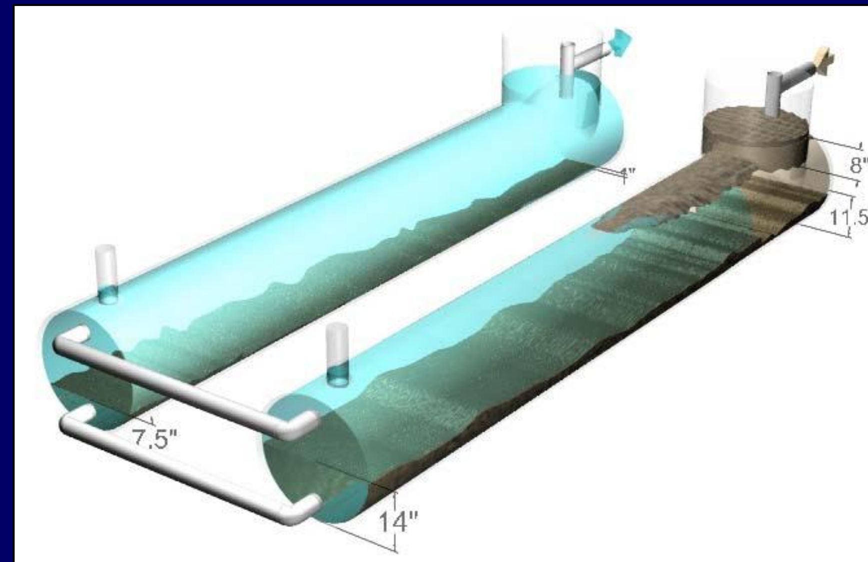
- Shape not as important as L:W, SA and compartmentation
- Compartmentation restricts most digestion to the first compartment and mitigates interferences in the outlet zone
- Connection between compartments likely important, but studies inconclusive

<u>Influent/Effluent Appurtenances</u>

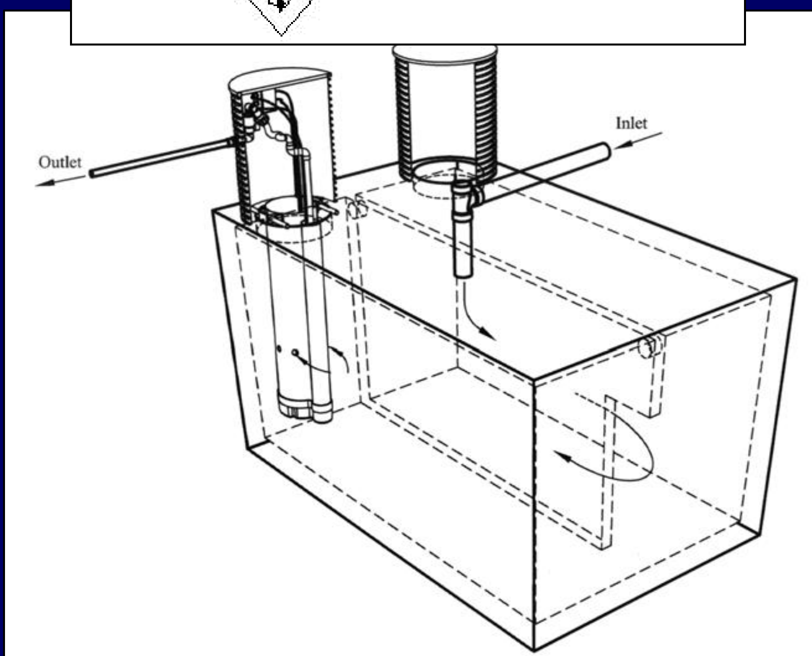
- Effluent screens and baffles help to prevent resuspended and neutral buoyancy solids from entering outlet devices
- Effects of specific devices difficult to isolate in experiments
- Minimal published data on effluent screens (there is an industry testing standard, NSF 46)

Alternative Septic Tank Designs

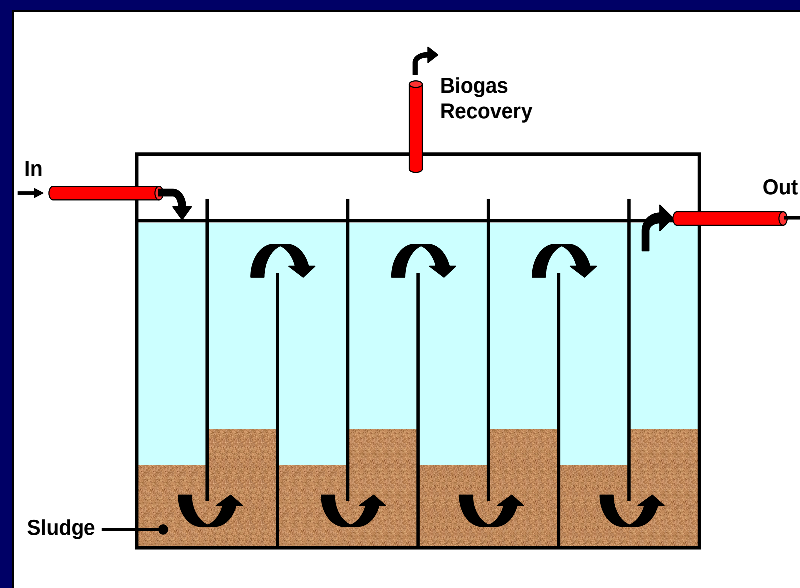




from: Waterloo Biofilter (Jowett, 2006)

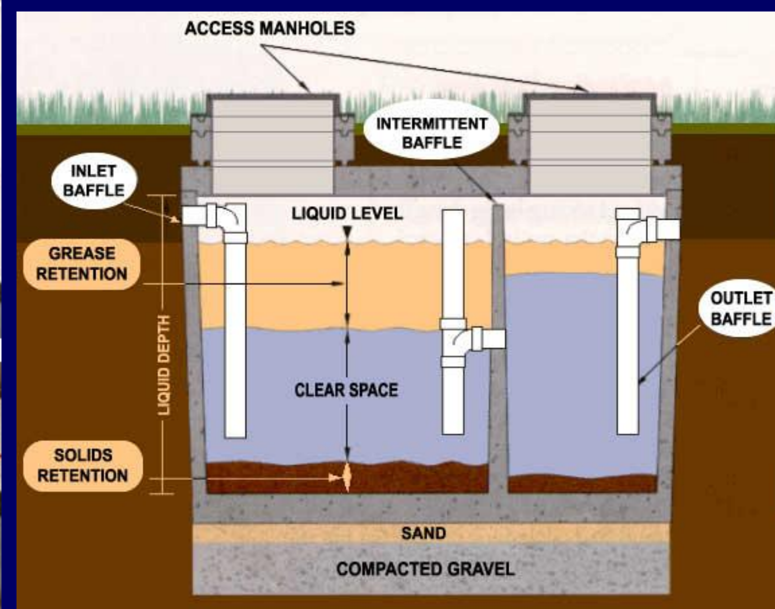


from: Seabloom, et al. (1982)



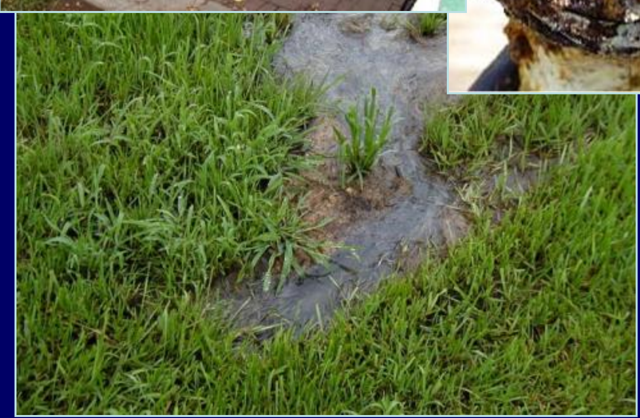
Grease Interceptors or Traps

- FOG removal from dedicated food service wastewaters
- Two types
  - Large interceptors provide relatively long HRT to cool water and float grease
  - Small undersink traps remove grease using other physical and hydraulic methods



Grease Interceptors or Traps

- Plumbed to only receive food service wastes
- Effluent from grease removal unit is directed to septic tank influent
- Little consensus on sizing and factors affecting performance
- Characteristics (including management and operating practices) of food service facilities are important
- Design elements *may be* prescribed by state or local codes
  - Sizing requirements
  - Compartmentation (baffles)
  - Effluent screening devices
  - Usually standard designs, but engineered units may be used for larger or non-traditional applications
- Need to be maintained!



Tank Materials

- Precast reinforced concrete
  - One-piece vs. two-piece
- Plastic
- Built-in-place

Precast Concrete Tanks

- Reinforcing
- Concrete compressive strength
- Honeycombing
- Uneven joint
- Reinforcing wire exposure

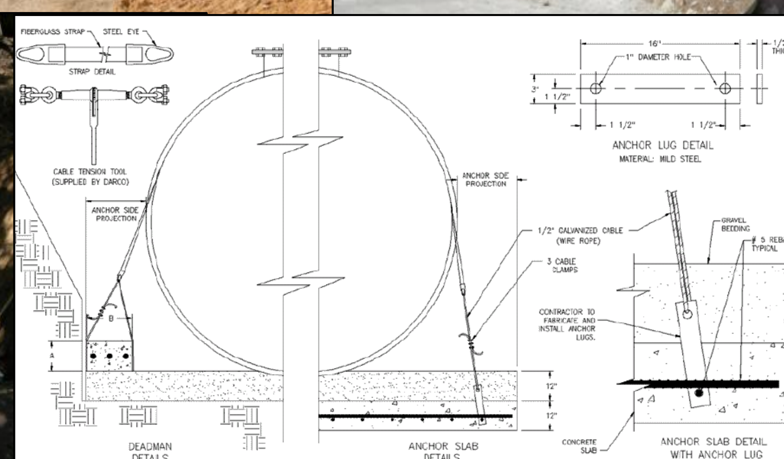
Tank Installation Provisions

- Traffic loading
- Anti-buoyancy
- Excavation and bed prep
- Risers
- Pipe penetrations
- Waterproofing
- Grading/landscaping





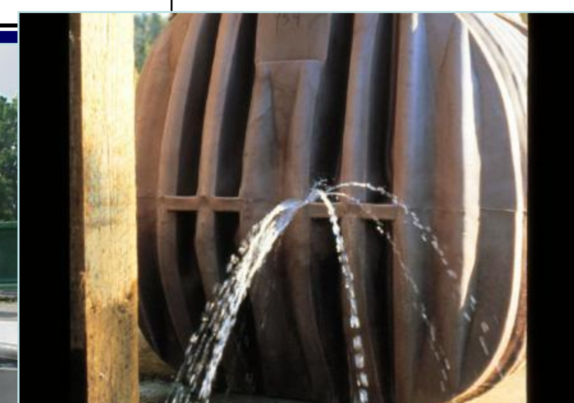




Tank Testing

- Strength/structural integrity
- Watertightness

Standard	Preparation	Pass/fail criterion
	Hydrostatic test	
C 1227, ASTM (1993)	Seal tank, fill with water, and let stand for 24 hours. Refill tank.	Approved if water level is held for 1 hour
	Seal tank , fill with water, and let stand for 8 to 10 hours. Refill tank and let stand for another 8 to 10 hours.	Approved if no further measurable water level drop occurs
	Vacuum Test	
NPCA (1998)	Seal tank and apply a vacuum of 2 in. Hg.	Approved if 90% of vacuum is held for 2 minutes.
	Seal tank and apply a vaccum of 4 in. Hg. Hold vacuum for 5 minutes. Bring vacuum back to 4 in. Hg.	Approved if vacuum can be held for 5 minutes without a loss of vacuum.



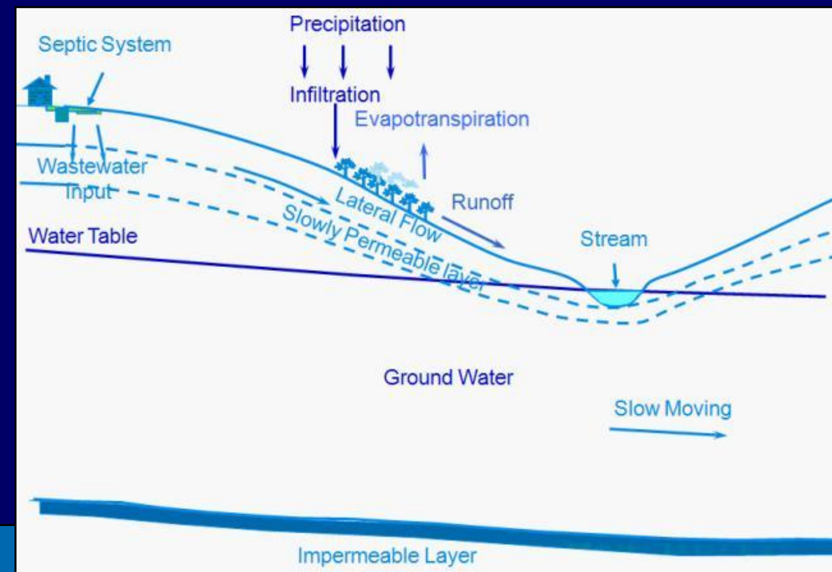
More Information

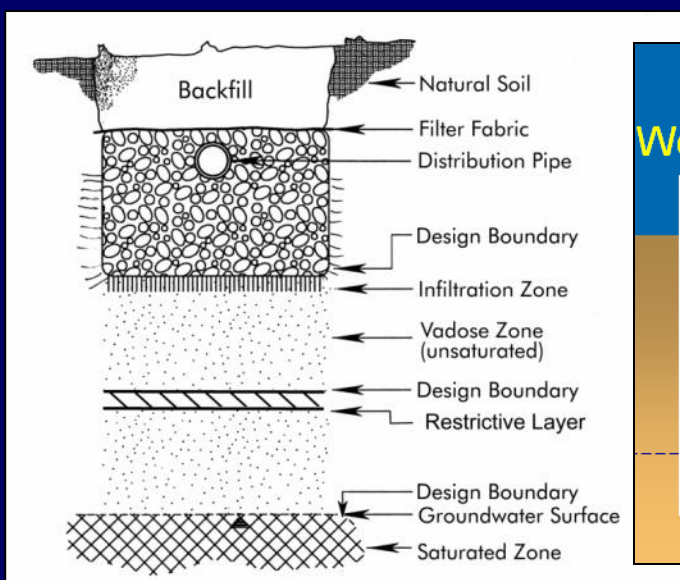
- Septic Tanks
  - CIDWT Practitioner Curriculum
    - http://www.onsiteconsortium.org/Ed_curriculum.html
  - D'Amato (2008) *Factors Affecting the Performance of Primary Treatment in Decentralized Wastewater Systems*
    - http://www.ndwrcdp.org/research_project_04-DEC-7.asp
    -
- Grease Interceptors or Traps
  - International Association of Plumbing& Mechanical Officials (IAMPO) Uniform Plumbing Code (UPC)
    - www.iapmo.org
  - Ducoste (2008) *Assessment of Grease Interceptor Performance*
    - http://www.ndwrcdp.org/research_project_03-CTS-16T.asp

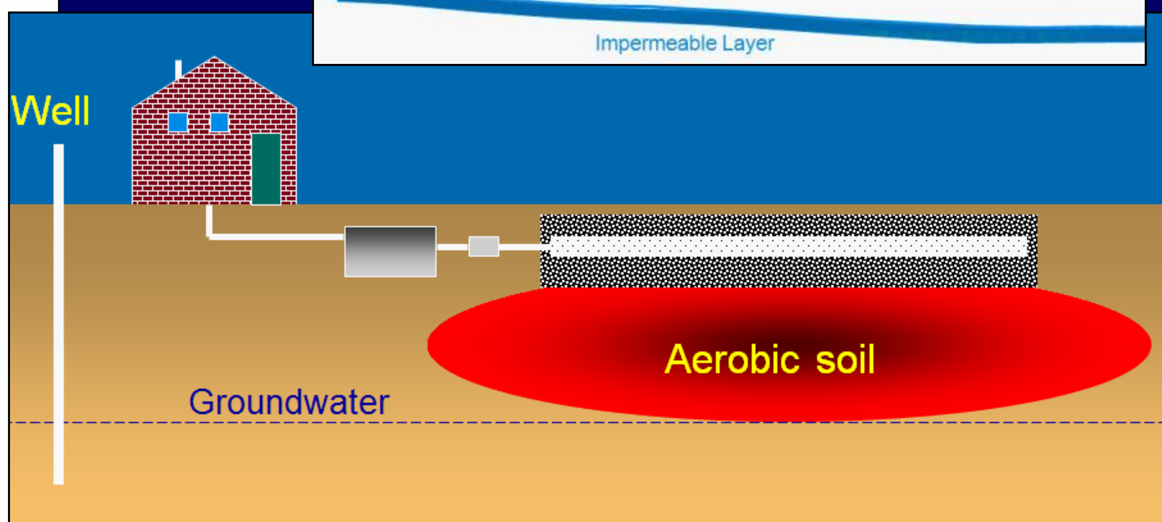
Soil-Based Treatment

Soil Treatment Unit

- Treatment via filtration
  - Physical
  - Chemical
  - Biological
- Dispersal into environment
  - Recharge aquifer
  - Restore hydrology

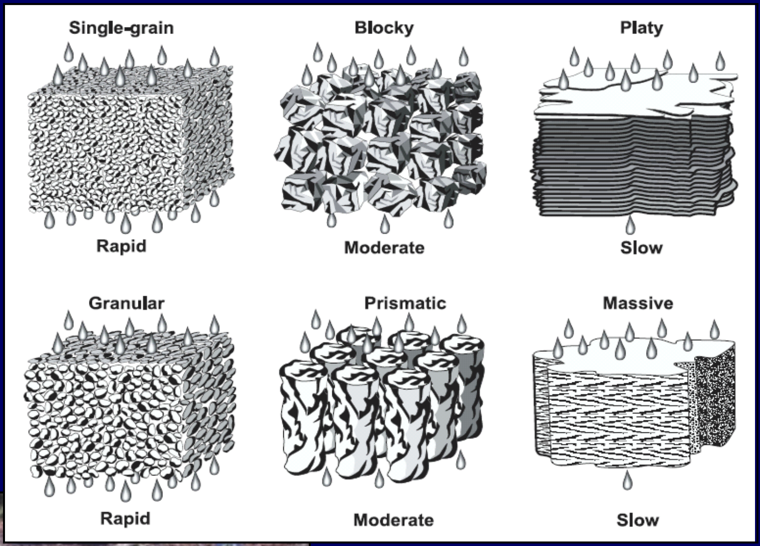


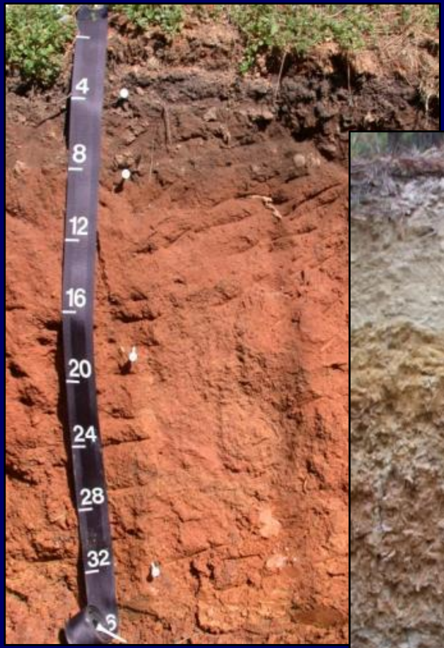


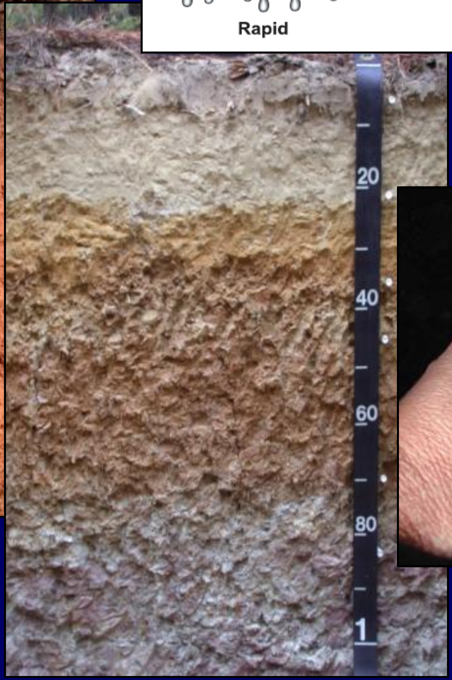


Soil Treatment Unit

- Soil characterization
  - Color (wetness, parent mat’l, organics)
  - Texture (sand, silt, clay)
  - Structure
  - Mineralogy and Consistence
- Soil horizons
  - O = organic layer
  - A = topsoil
  - (E = mineral)
  - B = subsoil
  - C = substratum
- Restrictive horizons
  - Unpermeable clay
  - Bedrock
  - Groundwater table

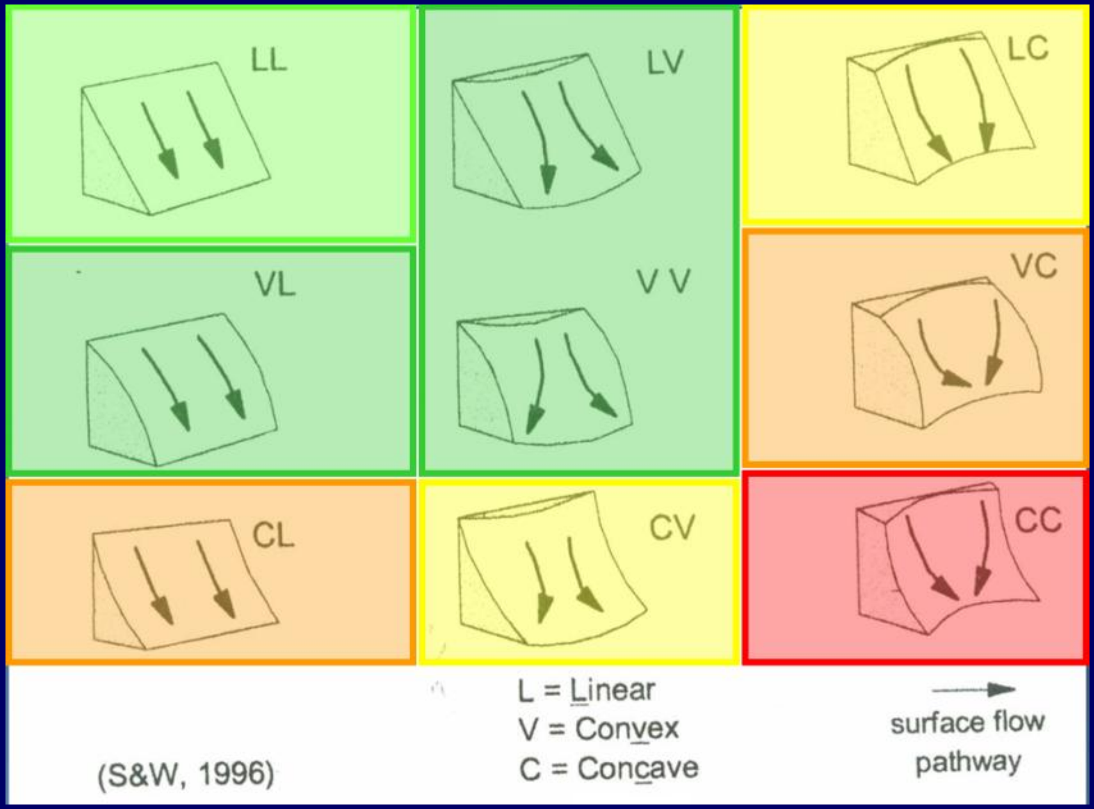






Soil Treatment Unit

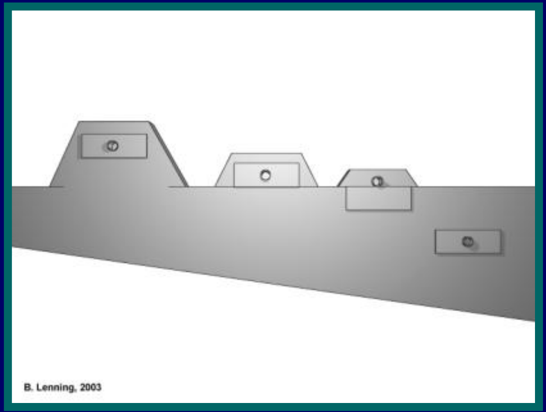
- Landscape position
- Advanced analyses
  - Pits
  - Deep borings
  - Soil wetness/monitoring
  - Saturated hydraulic conductivity measurement (Ksat)
  - Hydrogeologic evaluation (mounding, lateral flow)
- **Match system to the site!**



Soil Treatment Unit - Siting

- Allowable (long term) application rate: aerial vs. trench interface basis
  - **Soil characteristics**
  - Effluent characteristics
  - Dispersal type
- Setback distances (property lines, surface waters, wells, etc.)
  - Soil characteristics
  - Effluent characteristics
  - Dispersal type
- Dispersal depth
- Repair/replacement area allowance
- Flow rate

- Example
  - LTAR = 0.4 gpd/sf (aerial basis)
  - Design flow = 3,000 gpd
  - Required drainfield area = 3,000 gpd ÷ 0.4 gpd/sf = 7,500 sf
  - Also, need to account for
    - Repair area
    - Setback distances



(a) Every sanitary sewage treatment and disposal system shall be located at least the minimum horizontal distance from the following:

(1)	Any private water supply source, including any well or spring	100 feet;
(2)	Any public water supply source	100 feet;
(3)	Streams classified as WS-I	100 feet;
(4)	Waters classified as S.A.	100 feet, from mean high water mark;
(5)	Other coastal waters	50 feet, from

Soil Treatment Unit

- Objectives
  - Aerobic treatment (alternating saturated/unsaturated conditions)
  - Improved treatment by dosing entire drainfield area with relatively small, frequent doses
- Dispersal system architecture
  - Conventional gravel-filled trench
  - Chamber/gravelless
  - Direct dispersal (drip, spray)
  - Bed
  - Considerations
    - Regulatory
    - Application depth
    - Footprint/size
    - Layout options

Distribution Design for Soil Treatment

Distribution System Options

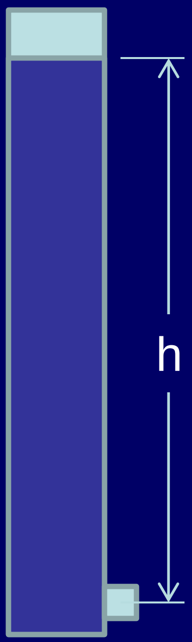
- Gravity/serial distribution
- Gravity/parallel distribution (distribution box)
- Siphon or pump-dosed to gravity-flow drainfield
- Siphon or pump-dosed flow splitter (pressure manifold)
- Pressure dosing (low pressure, drip/spray irrigation)

Distribution System Design

- Orifice Equation (for flow-splitting manifold)

$$Q = 13d^2h^{0.5}$$

  – Where
    - Q=flow per orifice (gpm)
    - d=diameter of orifice (inches)
    - h=pressure head (feet)
    - **For low pressure systems, use 11.79 instead of 13**



1 psi = 2.31 ft. water

Flow Splitting Manifolds

- aka, Pressure Manifold
- Used to split flow to gravity distribution lines
- Can use different orifice or tap sizes to achieve different flow rates for lines of different lengths
- Can vary operating pressure head to achieve different flow rates as desired
- Make sure manifold diameter is sufficient to handle flow (see http://www.deh.enr.state.nc.us/osww_new/new1/aidsmainten.htm for resources)

A. Sch 40 taps.

Holes Size

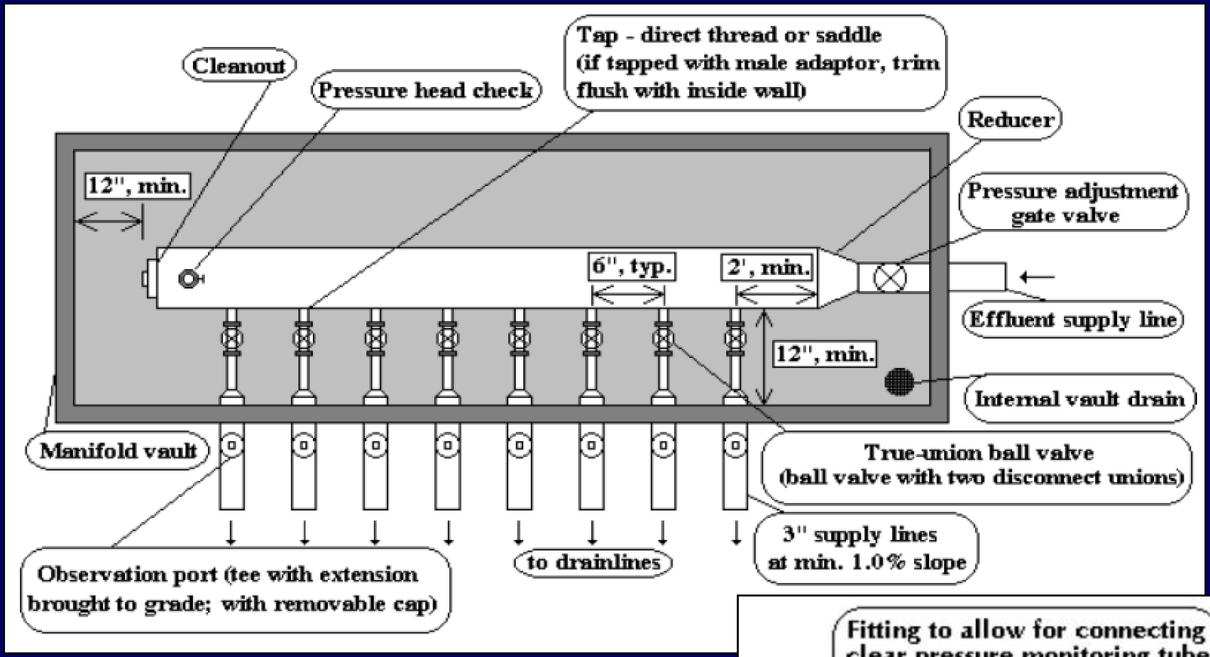
Head (ft)	½ -inch (.622)	3/4-inch (.824)	1-inch (1.049)	1-1/4 inch (1.38)	1-1/2 inch (1.61)	2-inch (2.067)
1.5	6.16	10.8	17.5	30.3	41.3	68.0
2	7.11	12.5	20.2	35.0	47.7	78.5
2.5	7.95	14.0	22.6	39.1	53.3	87.8
3	8.71	15.3	24.8	42.9	58.4	96.2
3.5	9.41	16.5	26.8	46.3	63.0	104
4	10.1	17.7	28.6	49.5	67.4	111

B. Sch 80 taps.

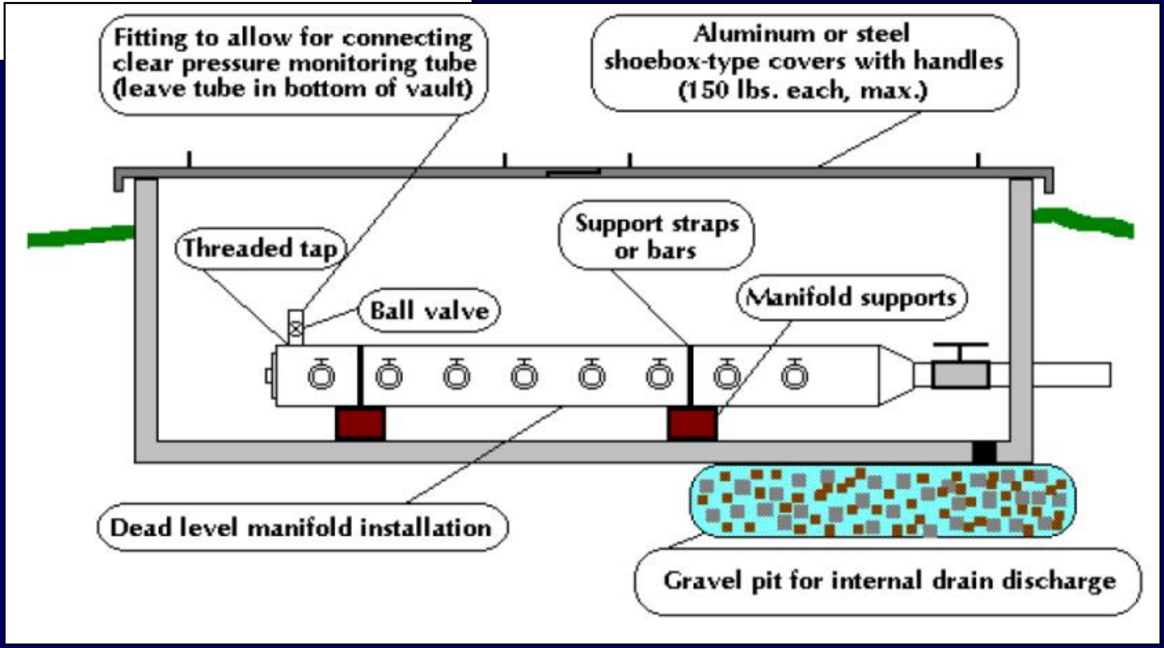
Hole Size

Head (ft)	½ -inch (.546)	3/4-inch (.742)	1-inch (.957)	1-1/4 inch (1.278)	1-1/2 inch (1.50)	2-inch (1.939)
1.5	4.75	8.77	14.6	26.0	35.8	59.9
2	5.48	10.1	16.8	30.0	41.4	69.1
2.5	6.13	11.3	18.8	33.6	46.2	77.3
3	6.71	12.4	20.6	36.8	50.7	84.7
3.5	7.25	13.4	22.3	39.7	54.7	91.4
4	7.75	14.3	23.8	42.5	58.5	97.8

Manifolds for Sloping Site

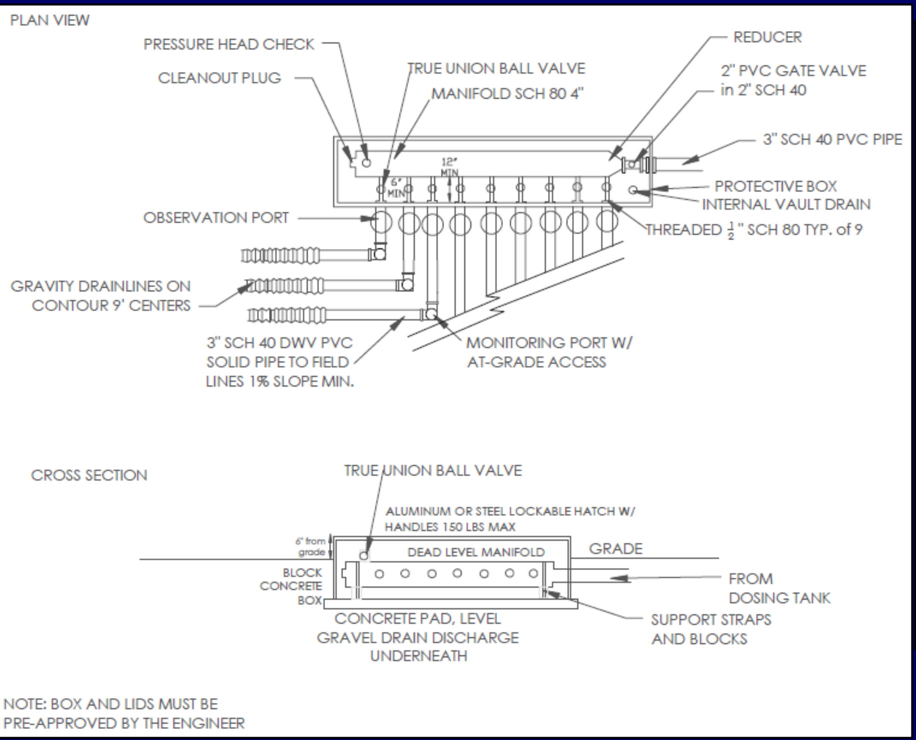


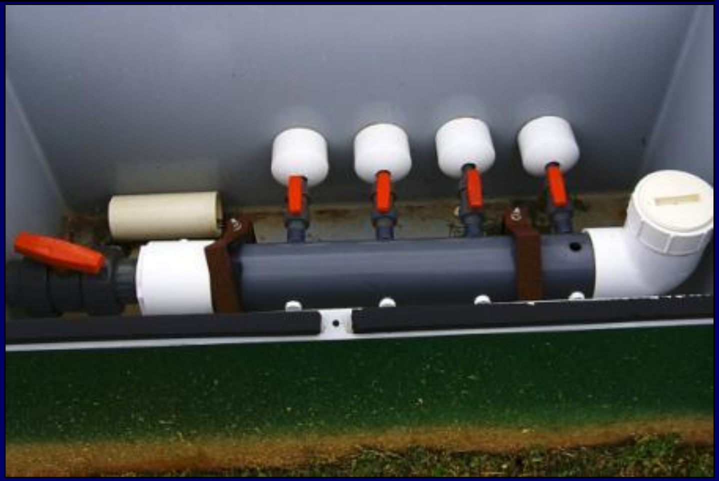
Plan View

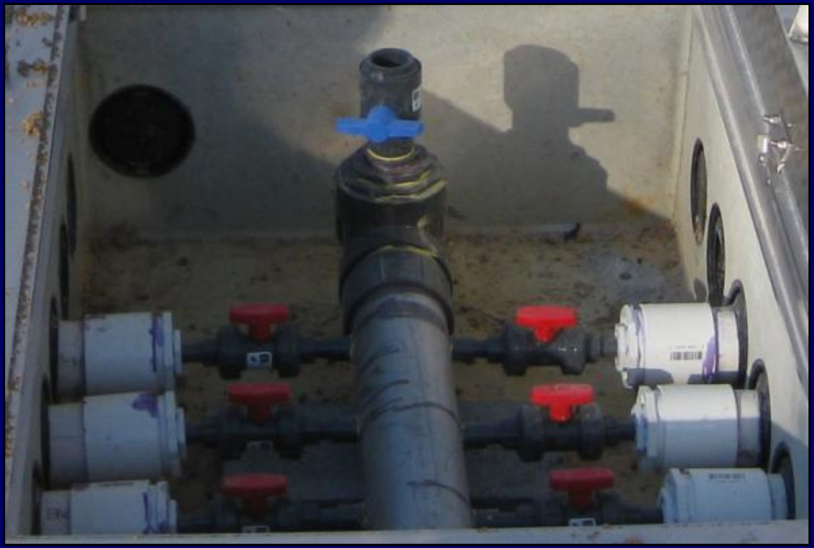


Profile View

Manifolds for Sloping Site







Pressure Manifold Design

Example

- Drainfield has three 80’ lines and three 60’ lines
- Design a pressure manifold to load each line equally

Solution

- Flow to 60’ lines will need to be ~ (60/80, or 75%) the flow to 80’ lines
- Select a 2’ pressure head to start and look for appropriate tap sizes
  - ¾” SCH 40 = 12.5 gpm
  - 1” SCH 80 = 16.8 gpm
  - 12.5/16.8 = 74.4%
- Pumping rate = 3(12.5) + 3(16.8) = 88 gpm

A. Sch 40 taps.

Holes Size

Head (ft)	½ -inch (.622)	3/4-inch (.824)	1-inch (1.049)	1-1/4 inch (1.38)	1-1/2 inch (1.61)	2-inch (2.067)
1.5	6.16	10.8	17.5	30.3	41.3	68.0
2	7.11	12.5	20.2	35.0	47.7	78.5
2.5	7.95	14.0	22.6	39.1	53.3	87.8
3	8.71	15.3	24.8	42.9	58.4	96.2
3.5	9.41	16.5	26.8	46.3	63.0	104
4	10.1	17.7	28.6	49.5	67.4	111

B. Sch 80 taps.

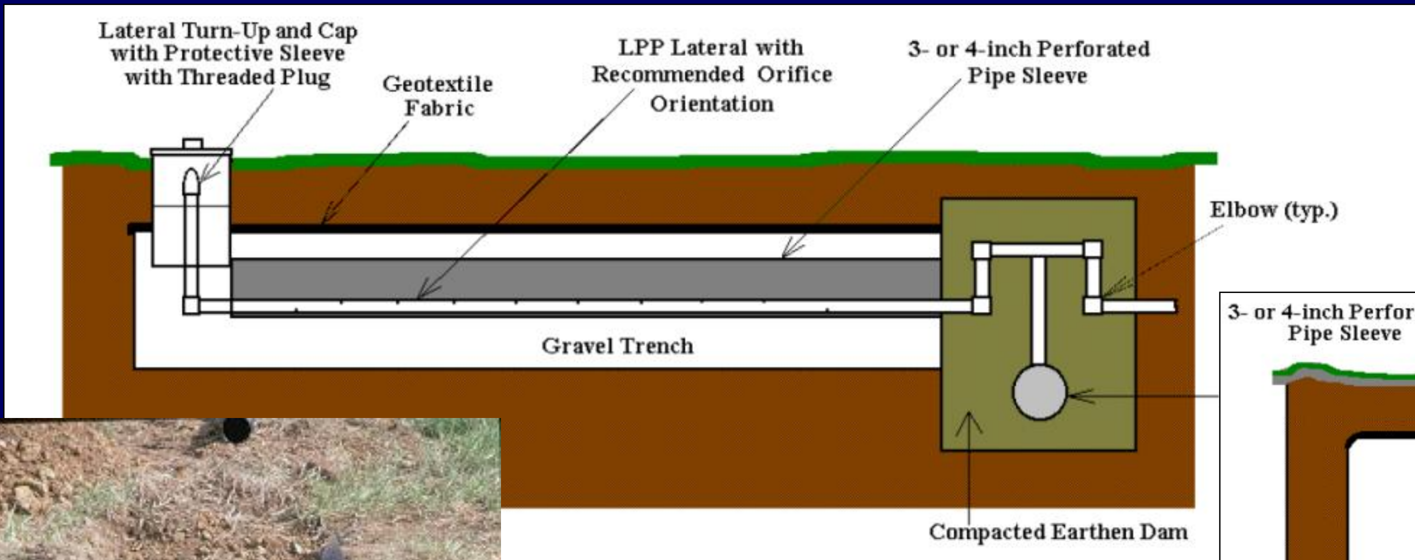
Hole Size

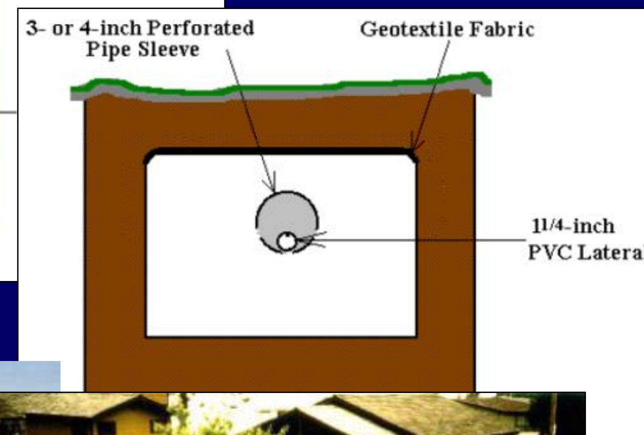
Head (ft)	½ -inch (.546)	3/4-inch (.742)	1-inch (.957)	1-1/4 inch (1.278)	1-1/2 inch (1.50)	2-inch (1.939)
1.5	4.75	8.77	14.6	26.0	35.8	59.9
2	5.48	10.1	16.8	30.0	41.4	69.1
2.5	6.13	11.3	18.8	33.6	46.2	77.3
3	6.71	12.4	20.6	36.8	50.7	84.7
3.5	7.25	13.4	22.3	39.7	54.7	91.4
4	7.75	14.3	23.8	42.5	58.5	97.8

Low Pressure Distribution

- aka, Low Pressure Pipe (LPP)
- Used to distribute effluent evenly over an area
- Vary orifice size and spacing, and operating pressure head to achieve different short term loading rates
  - Orifice size = 1/8 – 3/16” typ.
  - Orifice spacing = 1-15’, depending on the application
  - Pressure head = 2-5’ typ.
  - Line spacing = 2-10’
- On sloping sites, may need to compensate for varying pressure head and “drainback” to lower laterals
- Individual trenches and lines need to be installed level to prevent localized overloading

Low Pressure Distribution





Low Pressure Design

Pressure Head (feet)	Pressure Head (PSI)	Drilled Hole Diameter (inches): 3/32*	1/8**	5/32	3/16	7/32	¼
		Flow Rate (gallons per minute)					
1	0.43	0.10	0.18	0.29	0.42	0.56	0.74
2	0.87	0.15	0.26	0.41	0.59	0.80	1.04
3	1.30	0.18	0.32	0.50	0.72	0.98	1.28
4	1.73	0.21	0.37	0.58	0.83	1.13	1.48
5	2.16	0.23	0.41	0.64	0.93	1.26	1.65
6	2.60	0.25	0.45	0.70	1.02	1.38	1.81

$$Q = 11.79 d^2 h^{0.5}$$

Low Pressure System Design

<u>Example</u>

- Drainfield has four 60’ lines on a sloping site
- Design an LPD system to load each line equally

- Line 1 (top) = 105’ elev
- Line 2 = 104’
- Line 3 = 103’
- Line 4 (bottom) = 102’

<u>Solution</u>

- Top line will have lowest pressure, design for min. 2’ PH
- Line 2 = 3’, Line 3 = 4’, Line 4 = 5’ PH
- Use a 5’ spacing of 5/32” holes on Line 1
- Line 1 will have 12 holes (60’/5’) and be loaded at 0.41/hole = 4.92 gpm
- Using 5/32” holes, Line 2 will have an orifice flow of 0.50 gpm
- 4.92 gpm/0.5 gpm = 10 holes
- 60’ line/10 holes = 6’ hole spacing
- And so on for the other lines…
- Can also vary hole size or add separately-valved subfields or zones
- Also need to consider <u>manifold pipe size</u>, <u>lateral size</u>, and <u>dose volume</u>

Line	Elev.	PH	Q/hole	# holes	Hole space	Q/line
1	105’	2’	0.41	12	5.0’	4.92
2	104’	3’	0.50	10	6.0’	5.00
3	103’	4’	0.58	8	7.5’	4.64
4	102’	5’	0.64	7	8.5’	4.48

Drip/Spray Irrigation

- Used to distribute effluent evenly over an area, at surface or shallow burial depths that intercept root zone
- Variety of emitter types (or spray patterns), flowrates, spacing to accommodate different applications
- Many systems have distribution devices (emitters, spray heads) that provide consistent flowrates across a range of operating pressures
- Dead level placement not as critical
- Simplified and flexible installation methods
- Typically requires pretreated effluent

Spray Irrigation






Drip Irrigation






Drip Irrigation

Upcoming Webinar Sessions

Date	Topics (All @ 12 noon EST)	Presenter
November 8	*Overview of Centralized and Decentralized Treatment*	*Barry Tonning*
November 15	*Decentralized Treatment: Processes & Technologies*	*Jim Kreissl*
November 22	*Focus on Wastewater System Design: Part 1*	*Vic D'Amato*
November 29	*Focus on Wastewater System Design: Part 2*	*Vic D'Amato*
December 7	*Management Approaches for Wastewater Systems*	*Juli Beth Hinds & Khalid Alvi*
December 14	*Integrated Water Resource Management*	*Vic D'Amato*